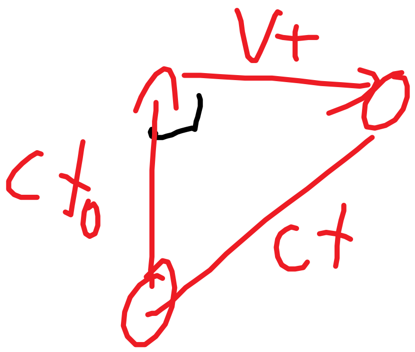
Mechanical Universe Lorentz
https://www.youtube.com/watch?v=feBT0Anpg4A&index=42&list=PL8_xPU5epJddRABXqJ5h5G0dk-XGtA5cZ
Minute physics Relativity
https://www.youtube.com/watch?v=ajhFNcUTJI0
distances
https://www.youtube.com/watch?v=s5S-hA9uKEM
energy
https://www.youtube.com/watch?v=hW7DW9NIO9M

Homework Derivation of Time Dilation:



$$a^2+b^2=c^2$$
$$(vt)^2+(ct_0)^2=(ct)^2$$
$$v^2t^2+c^2t_0^2=c^2t^2$$
$$c^2t_0^2=c^2t^2-v^2t^2$$
$$c^2t_0^2=(c^2-v^2)t^2$$
$$\frac{c^2}{(c^2-v^2)}t_0^2=t^2$$

$$\left(\frac{1}{1-\frac{v^2}{c^2}}\right) t_0^2 = t^2$$

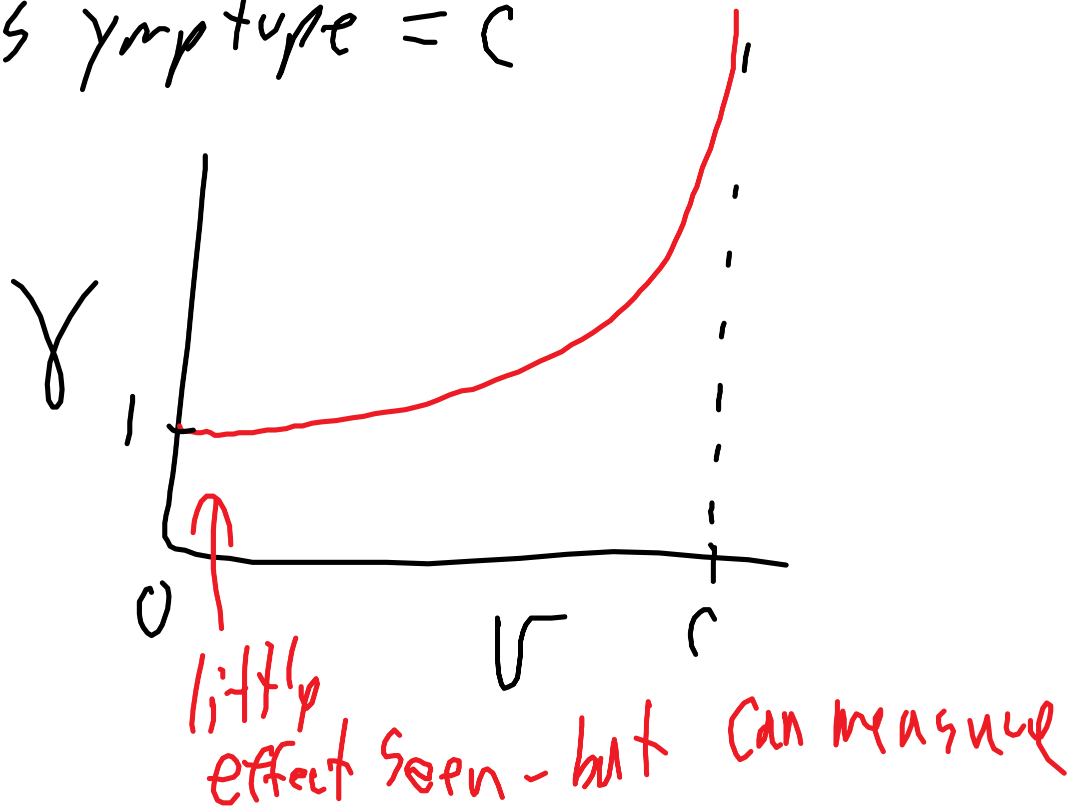
$$t = \left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\right) t_0$$

$$\gamma$$

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\boxed{t = \gamma t_0}$$

asymptote $= c$



big idea - time is dependent on relative velocity and on the position.

t is the relativistic time, time for events with relative motion.
t_o is called the proper time - for events with no relative motion, co-local events.
γ is the relativistic factor that occurs in many equations in relativity. =1 at low speeds, asymptote is c, cannot accelerate to the speed of light.

This follows from the 2 postulates of special relativity:
1. speed of light is the same in all frames.
2. laws of physics are the same in all inertial reference frames.

Here's the weirdness:
Imagine the Twins Paradox. (not really a paradox, it is an apparent paradox - contradictory idea).

One twin flies off in a spaceship at 0.99 c to Alpha Centauri 4.5 light years away and returns at the same speed. How much time passes for the travelling twin and the stay at home twin?

Problem - in the frame of reference of the travelling twin, the stay at home twin is moving so their clock is moving slower.
In the frame of the stay at home twin, the travelling twins clock is moving slower.

What's the deal?

Solution:

1. time depends on position as well as motion.
2. when you change directions, you change spacetimes - alter relative time on Earth.

Best observed using a space-time diagram - a Minkowski diagram.

equation:
$x'=\gamma(x-vt)$ $\Delta x'=\gamma(\Delta x-v\Delta t)$
positions on the x axis are contracted in the direction of the relative velocity, v.

$t'=\gamma(t-(vx)/c^2)$

times are dependent on position, so simultaneity (events being at the same time) depend on position and velocity.

For the trip to Alpha Centauri,

a) how long does the outward trip take to the

Earth twin, Jeff?

b) how far is the outward trip to the travelling twin, Marco?

c) how long does the outward trip take for Marco?

d) What year is in on Earth when Marco turns around? (tricky)

e) How long does the return trip take in each frame of reference?

Read the Cambridge guide, relativity.

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problems 7, 17, 25,27